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THE CONTROL OF INSECTS LIABLE TO BE IMPORTED IN RAILWAY CARS

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The desire to check the increase or to prevent the establishment of insect pests in British Columbia has always been one of the main objects of economic entomologists and horticultural field inspectors in pursuit of their official duties. This object has been especially emphasized as regards fruit-infesting insects for the reason that horticulture and the cultivation of fruit has been considered, in the past, the "first arm" of the agricultural industries of the Province. The Codling Moth is particularly classed as an undesirable insect pest of apples and pears, liable of importation into any given fruit-growing section, and it is with this insect and its control that this article has special reference. As a matter of general information, the Codling Moth, until the present day, has not become generally distributed throughout the fruit-growing areas of the Province, neither is it as yet regarded as an insect which requires attention as a regular established orchard pest. There are between 30,000 and 40,000 acres of fruit in the Province of British Columbia, three-quarters of which acreage is located in that part of the Province known as the "dry Interior" where irrigation is commonly practised, and of this 20,000 acres close upon 850 acres were under quarantine at the close of the year 1921, but it is probable that not much more than 300 acres were actually infested with the Codling Moth. Where this insect occurs the control operations are under Government surveillance, the burden of control not having as yet been thrown upon the shoulders of individual growers.

This is an interesting point for the general information of entomologists, but in as much as the Codling Moth does occur in the province to a somewhat limited extent the problem of control may be and has been considered under two distinct phases.

(1) The control of the insect within the Province.

(2) The closing of the avenues of importation.

The first phase detailing the stringent regulations which govern an area under quarantine by Government, has been dealt with on other occasions. It will not be necessary to mention this information again at this time except to state that the control operations are strictly based upon eradicative procedures and that total eradication of the Codling Moth has been successful in eight outbreaks out of twenty that have occurred until the present time. The following table indicates the degree of success that has attended the operations on the present infested areas as it affects the fruit growing areas of the Interior.

TABLE 1. Showing the number of larvae of the Codling Moth taken in British Columbia in the fruit-growing areas of the Okanagan and Similkameen Valleys and points on the main line of the Canadian Pacific Railway east from North Bend.

Year	Acreage under quarantine	Number of larvae and pupae taken
1915	335	10,000
1916	330	3,500
1917	330	600
1918	375	394
1919	500	373
1920	645	174
1921	850 approx.	785

The second phase of the problem is as important as the first and in as much as certain lines of study in this connection have been conducted, which have now reached a certain stage of finality, this article has been written to illustrate not only the stage of development of the fruit industry of British Columbia, the centres of outbreak of the Codling Moth, but also the means and methods of introduction of this pest with suggestions for preventing its further importation.

According to the Market Reports and the Agricultural Records of the Department of Agriculture but particularly from a brief prepared under the direction of the British Columbia Fruit Growers Association before a sitting of a Federal Tariff Commission in September, 1920, the following statistical data are noted.

In 1891 the fruit industry of British Columbia boasted approximately 450,000 fruit bearing trees; in 1901, 649,091; in 1911, 2,677,486; in 1913, 2,978,993; while in 1920, 1,165,369 apple and pear trees alone were producing fruit in the Okanagan and Similkameen Valleys and at points on the main line of the Canadian Pacific Railway east of North Bend. The production of apples far outdistances, in numbers, the quantity of other tree fruits grown, representing 77 per cent of all trees planted. The yield from these trees is recorded as follows:

1910	210,000	boxes of apples
1911	250,000	
1912	430,000	
1913	477,000	
1914	685,000	
1915	787,750	
1916	1,289,980	
1917	1,502,921	
1918	1,343,450	
1919	2,524,132	
1920	1,500,000	
1921	3,150,000	(estimate to date—October)

From these records it may be quite readily seen that the heavy plantings and the greatest expansion in the tree-fruit industry occurred in British Columbia during 1909, 1910 and 1911, with a sudden rise in the apple output in 1916 and again during the past few years when the trees became more mature. Today between $20,000,000 and $25,000,000 of capital is invested in the British Columbia apple industry, out of a total of about $35,000,000 for all fruits raised in the Province. This valuation approximates that of Nova Scotia, doubles that of Quebec and is less than half that of Ontario.

These figures, while known to horticulturists, are presented in this article to indicate to the minds of entomologists the stage of development of the fruit industry and the relation of that industry to the numbers and varieties of orchard pests present. The Codling Moth, without question, ranks first as the most serious insect threatening the apple industry of the Province. Oregon (Wilson) estimates the annual loss to the apple industry of that State due to the Coding Moth as 25 per cent of the total crop. Washington (Melander) claims an annual loss of $200,000 on the average yield of 1,500 cars. Wenatchee district (Darlington, 1918) estimated a $1,000,000 loss in fresh fruit prices on an 8,350 carload output, but as between 7 per cent and 8 per cent of infested fruit was used in by-product factories an actual loss of $800,000 was sustained. Ontario (Caesar) loses over $2,000,000 a year from this insect and these records, while appearing high, do not take into consideration the cost of orchard spraying operations. The probable effect of the Codling Moth on the apple industry may thus be easily computed.

The valleys suitable for growing fruit in the Province of British Columbia run north and south, connecting with the fruit valleys of the State of Washington and Idaho. Up to the present time there is not, neither has there been, any direct connecting chain of planted orchards; a distance of twenty-five miles and more has separated the fruit-growing sections of the two countries. In other words there has been no infestation of the Codling Moth from infested territory to the south of British Columbia by flight of the moths. The fact remains, however, that the Codling Moth has been taken in British Columbia at various times, in varying degrees of intensity, during the past fifteen years. These centres of infestation are referred to as outbreaks and these outbreaks have been entirely caused by the actual importation of larvae, pupae and moths during the fruit shipping season or through settlers' effects during winter. There is little doubt that similar conditions occur in all fruit raising districts in North America and that the Codling Moth is continually being imported into enterprising fruit sections without the knowledge of the majority of the inhabitants. The conditions in British Columbia, with respect to the youth of the industry, presents an example which is worth recording. Let us examine, therefore, the outbreaks as they have occurred in the Province until the present time, and note how they have been caused in the light of the best information on the means of introduction.

TABLE 2. Showing the number of outbreaks of the Codling Moth in British Columbia and the probable means of introduction.

Year discovered	Locality found infested	Probable cause and remarks
1905	Victoria	Californian pears
	Kamloops	Ontario apples.
	Kaslo	Ontario apples.
1912	Armstrong	Oregon nursery cases or infested railway cars
	Rutland	Ontario fruit in settlers' effects.
1913	Kelowna	Infested railway cars.
1915	Kelowna	Infested railway cars, second outbreak.
	Okanagan Landing	Infested railway cars.
	Westbank	Apple boxes from Kelowna.
	Eburne	U. S. infested fruit.
1916	Walhachin	Infested railway cars.
1917	Vernon	Fruit from Okanagan Landing.
1918	Okanagan Landing	Infested railway cars, second outbreak.
1919	North Bend	Infested railway cars.

1920	Swan Lake	Infested railway cars.
	Kelowna	Reoccurrence from old centre.
	New Westminster	U. S. infested fruit.
	Walhachin	Infested railway cars, second outbreak.
1921	Kamloops	Infested railway cars, second outbreak.
	Okanagan Landing	Infested railway cars, third outbreak.

It may be seen from this table that the Codling Moth has been imported into British Columbia through the following channels:

1. Infested railway cars, 55 per cent.
2. Infested imported fruit, 30 per cent.

10 per cent of the outbreaks have been caused by the local movement of fruit and fruit boxes from infested territory and 5 per cent has been the reoccurrence of an outbreak that was believed to have been eradicated.

British Columbia may roughly be divided into three fruit-growing areas, viz.: the Coast, including Vancouver Island and the Lower Fraser Valley; the Interior, including the irrigated fruit areas of the Okanagan and Similkameen Valleys and points on the main line of the Canadian Pacific Railway east of North Bend; the Kootenays or Eastern British Columbia. In the examining of the table given above we find that from the standpoint of the Interior fruit-growing areas, where the great majority of the apples are grown and where the Codling Moth if it became a general orchard pest would be far more serious than at the Coast, that sixteen outbreaks have occurred, 69 per cent of which have been directly attributed to infested railway cars, to which may be added 19 per cent caused by the removal of fruit or boxes from an area infested through the medium of railway cars and 12 per cent caused through the importation of infested fruits either in the box or in settlers' effects from Ontario or the United States.

It should be quite clear, therefore, that the infested railway car is by far the most important medium through which the Codling Moth may be introduced into new fruit districts. Our evidence on this point is quite clear, in as much as, larvae, pupae and adult moths have been taken in empty refrigerator railway cars rolled into the Okanagan Valley for the reception of local grown fruit. This point may be extended somewhat for the benefit of those who are not conversant with conditions.

Apples and pears are loaded into refrigerator cars in the fruit growing areas in the States of California, Oregon, Idaho, Washington and Montana. Many of these cars find their way for sale on the Canadian Prairies, and as the Codling Moth occurs in varying degrees of intensity in each of the States mentioned there is no doubt that the fruit is infested with Codling Moth larvae when it is loaded into the cars. Some of this American fruit also finds its way to Coast points in British Columbia and the records of the Provincial Fruit Inspection Department show that much of the fruit is infested with Codling Moth larvae. The fruit in the States to the south of British Columbia matures somewhat earlier than the local grown product, thus when the time arrives to move the British Columbia crop and requests are made for empty refrigerator cars or "reefers," many of these cars are found on the Prairies and in Vancouver ready for reloading. Hence they are rolled to any point requiring them for use particularly in the sale of the British Columbia product in the American markets. We are not concerned in this article as to where the local product finds its sale but we are

concerned with the empty railway car, which formerly held fruit in the same season, destined for loading at British Columbia points for export trade.

These cars have been examined too often to leave any doubt that they are the chief means of introducing the Codling Moth into British Columbia.

The following table shows the record of the number of cars inspected at one point in the Province and the degree of infestation.

TABLE 3. Showing the number of United States railway cars inspected at Okanagan Landing, B. C., with the number infested with live Codling Moth material.

Year	Number of foreign cars inspected	Number of cars infested with live Codling Moth	Number of live larvae, pupae and adults found
1918	58	10	21
1919	378	47	203
1920	181	14	47
1921	125 (to Sept. 7)	26	89

This does not take into consideration the number of cars found to contain empty pupal cases from which the adult moths have emerged. The above table proves definitely that healthy Codling Moth material is being imported into the Province year by year and that the larvae unquestionably have emerged from fruit shipped in the same year and probably within one month of the date of discovery. A very long and extended table might be built up to show the actual car numbers, the railway system to which the cars belong and to some extent the most recent point of loading of United States fruit and the number of cars found infested in some way or another, whether as live larvae or pupae or as empty pupal cases. There is no virtue in presenting such a table. We can content ourselves with the statement that fully 50 per cent of the United States refrigerator cars received in British Columbia are or have been infested with the season's larvae of the Codling Moth. As many as 150 empty pupal cases have been taken out of single cars at the point of inspection and 50 and 60 empty cases are commonly found. Of the 50 per cent of cars found infested an average of 25 empty pupal cases have been taken in each car in a single season.

Infested fruit in transit from the United States allows time for the Codling Moth larvae to mature, to vacate the fruit and to find some suitable crack or crevice in the apple box or in the car lining to form its cocoon. Cars unloaded of fruit on the Prairies thus contain larvae and these cars when required at some fruit loading station in British Columbia are rolled empty, often partly iced and frequently uncleaned. It has been the custom to clean these cars out in British Columbia just previous to loading. The original sources of infestation have undoubtedly been caused by this action. As this car movement usually occurs in mid-summer and until autumn there is every opportunity for larvae spun up in the car linings to mature, pupate and emerge. Temperatures inside these cars have been taken and they frequently register 80 and 90 degrees Fahrenheit. As frequently happens cars are held up on sidings for two or three weeks at a time, especially at the time pending the movement of the crop and tie-ups often occur with "empties" during the rush of the season to make way for loaded trains. When this happens and with ventilators open the adult moths have no difficulty in making their escape into the nearest orchard. The great majority of the larvae, their pupae or pupal cases are found in the crevices of the wood linings of the cars four feet from the floor to the ceiling. Nail holes, broken boards and loose beading are commonly chosen and it is not an unusual sight in a car in poor repair to see a dozen or more Codling Moth larval cocoons clustered on

the insulation paper lining beneath a loosened board. The importance of this method of introduction of a dangerous pest has been recognized in British Columbia for many years. Steps have been taken to lessen the danger but despite the willingness of railway operators to cooperate in every way possible, mistakes occur, with the result that outbreaks have taken place. The closest type of inspection system is unsatisfactory. The human element in the rush of the season causes the failure and mistakes are costly.

It has been evident during the past two years that other steps must be taken to bolster up the inspection system to better eliminate chances of failure. With this in mind treating cars at some point outside of the fruit-growing sections with gas, chemicals or heat has been considered. Icing cars to reduce the temperatures and so to check larval or pupal development has been carried in mind but after full consideration of the problem from all angles, including that of the railwayman, the application of heat is considered the most satisfactory.

It was thought probable that if steam were injected into the cars for a certain length of time, no damage would take place to the insulation, the Codling Moth larvae would be killed and the procedure would be rapid enough not to cause delay in the movement of freight. Consequently on May 1, 1920, a single car was treated with steam to determine the temperatures that could be reached in a certain length of time and its effect on insect life. Through the courtesy of the Canadian Pacific Railway Company the refrigerator car No. 282546, Bohn System, Dressed Meat Service, with a capacity of 1906 cubic feet with three ply insulated walls, was treated with steam supplied from a locomotive. A three inch rubber hose was inserted through the drainage vent at one end, under the pressure of 60 degrees.

Previous to the application of steam the inside temperature of the car registered 54 degrees Fahrenheit, with a relative humidity of 75 degrees. Outside shade temperature registered 63 degrees Fahrenheit. Specially constructed clinical self-registering thermometers, capable of registering 300 degrees Fahrenheit were tied to laths, which were let down on cords through one of the ventilators on the roof of the car, furthest away from the intake of steam. At intervals of 5, 10 and 15 minutes the steam was shut off on the engine for a sufficient length of time to remove the ventilator plug and one of the thermometers. The temperature records were as follows:

In 5 minutes the temperature registered 148 Fahrenheit.
In 10 minutes the temperature registered 182 Fahrenheit.
In 15 minutes the temperature registered 195 Fahrenheit.

A sack half filled with rice meal placed on the floor of the car in the centre with a self-registering thermometer in the centre of the sack registered 100 degrees Fahrenheit in 15 minutes.

The following insects were used in the experiment:

1. Codling Moth larvae overwintering in larval cocoons in folds of corrugated cardboard.
2. Cutworm larvae (*Noctua c-nigrum*) ½ to ¾ inches in length, buried in slightly moistened sand, two inches deep in six inch tin boxes without lids, and full grown larvae in sleeved mica chimneys.

3. Adults of *Epicnaptera americana,* moths and pupae of the same rolled in cotton batting and absorbent cotton in three inch square cardboard boxes with lids.
4. Eggs of the Oyster Shell Scale on apple twigs.

Two sets of this material were arranged, one set being suspended from the ceiling of the car in the centre and the other set on the floor in the centre of the car. Control or untreated material was also held for comparison.

It was not possible in this experiment to remove any of the material from the car under the 15 minute exposure but in this length of time all the forms of insect life were destroyed. No injury resulted to the car and in all respects the experiment was a pronounced success.

Further information was desirable, however, on the effect of steam on the insulation of cars, the cost of treatment, the time required to destroy Codling Moth material in cars in poor repair or partly iced. Consequently in August, 1921, four cars were treated with locomotive steam in the same way as in the previous year with the exception that a flattened iron pipe was inserted into the car beneath the closed door on one side.

The following table illustrates the points noted:

TABLE 4. Showing temperatures obtained in standard refrigerator cars following the application of steam and notes on the condition of the cars.

Car number	Steam applied in minutes	Temperature registered	Remarks
59533	10 minutes	164 Fahr.	Car in good shape; no defects, varnished. Insulation not affected.
96229	15 minutes	160 Fahr.	Car in fair condition; capacity 60,000; one bad split but the insulation not affected.
95004	20 minutes	160 Fahr.	Car in good shape; no defects, varnished, capacity 70,000; insulation not affected.
58441	20 minutes	175 Fahr.	Car in fair shape; one bad crack, paper lining showing, moisture present on paper lining.

In supplementing these notes it is observed that moisture condensed on the ceilings of the cars and drops continued to fall for at least half an hour after opening up. The walls while they were wet and warm on opening up dried rapidly and no ill effects were observed. In each of the cars mentioned above Codling Moth larvae and pupae were placed in paper cartons attached to the ceiling and laid on the floor. The following table indicates the results obtained:

TABLE 5. Showing the results of treatment with steam on Codling Moth larvae and pupae.

Car number	Number of larvae and pupae	Number left alive after treatment	Remarks on state of the car
58533	10	2 pupae	No ice in the bunkers.
96229	10	0	One foot of ice in bunkers.
95004	10	0	Two feet of ice in bunkers.
58441	10	0	No ice in the bunkers.

The results of these experiments indicate that Codling Moth larvae and pupae may readily be destroyed by steam heat in the ordinary refrigerator car in 15 minutes with the final registration of 160 Fahrenheit with or without ice in the bunkers. Through the kindness of the Canadian Pacific Railway officials the wood lining of the cars was removed at one or two places in each car and the insulation paper examined. The weakest spot in the car was chosen for

examination in each case and in every instance no damage resulted to the insulation, except in one instance where a badly broken board allowed moisture to condense on the paper lining, but apparently without lasting deleterious effects. In other words the experiments point clearly to the fact that no damage to the insulation will take place if the car is in good repair. As to the cost of treatment this point cannot be decided upon unless the exact number of cars requiring treatment in a season is known and until proper equipment is installed to take care of the proceedings as a regular operation.

In closing this article I would like to draw attention to the statistical data given as regards areas under quarantine, acreage in fruit and the captures of larvae and pupae in railway cars. Without the sincere cooperation of the Provincial Horticultural officials, notably Mr. W. T. Hunter, District Horticulturist for the Interior sections, and his assistant, Mr. H. H. Evans, these tables could not have been compiled or certified correct. Full acknowledgement is hereby given to the earnest support given by these officials not only in the preparation of this paper but also for the cooperative spirit always in evidence between entomologists and horticulturists in the study of the Coding Moth in the Province.

CONIFEROUS HOSTS OF THE IPIDAE OF THE PACIFIC COAST AND ROCKY MOUNTAIN REGIONS

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During the past few years our knowledge of the breeding habits of many of the bark-beetles has been greatly increased. Some of these species are very destructive, especially to the principal commercial trees such as sugar pine (*Pinus lambertiana*), western yellow pine (*Pinus ponderosa*), and Jeffrey pine (*Pinus jeffreyi*), Western White Pine (*Pinus monticola*) and Douglas Fir (*Pseudotsuga taxifolia*). The most injurious Ipid beetles infesting each tree species will be found in the host list marked with an asterisk.

Since many of these beetle species inhabit only one or a few species of trees, an accurate knowledge of the hosts is important to the forester engaged in the control of the insect depredations which become, or are liable to become epidemic. For instance, if the destructive insect will attack and become epidemic in only one coniferous species, the control work is much simplified, since it need deal only with the particular species of tree. If the insect attacks and breeds in several species of trees on the same area the control work is obviously much more complicated, as all species of trees infested by this beetle must be treated.

There has been considerable doubt expressed whether some species of beetles, as for instance *Dendroctonus monticolae* Hopk., attacking the lodgepole (*Pinus contorta* Loudon) will, when the progeny emerges, attack another species of tree such as a yellow pine, which it is also known to infest. If this assumption could be verified, epidemics in any one species could be exterminated or practically controlled without considering other species of trees infested with the same destructive beetle. It seems highly probable though that certain species of Ipids under endemic conditions will confine their attacks to one species of tree,

showing a preference to specific food; but that under epidemic conditions they will attack any of the tree species they are known to breed in. We do know, however, that certain species breed in only one particular species of tree or one group of tree species. Certain genera of these bark borers are even confined to certain generic groups of trees. Thus, in California, the genus *Dendroctonus* (with one exception) and the genus *Ips* are found wholly in the genus *Pinus*. The genus *Pseudohylesinus* is found (with one exception) in the fir group of trees, and *Phloeosinus* in the cypress and redwood group. There are notable exceptions, for example, a *Phloeosinus* is found in pine; one species in Canada and another in India.

The loose way in which entomologists refer to hosts under local names should be discontinued. Unless the exact locality is known such words as bull pine, tamarack, jack pine, spruce may mean any of a number of species. Spruce, for instance, is not found in California except in the extreme northwestern part; tamarack in California is a popular name for *Pinus contorta*, while in Washington and the interior of British Columbia it means *Larix occidentalis* and on the coast of British Columbia, *Abies amabilis;* spruce may mean *Pseudotsuga taxifolia* or it may mean a true *Picea*, while Jack Pine is either *Pinus contorta* or *Pinus divaricata*. The use of technical names is definite. Unfortunately many of our entomologists are not good botanists and wrong identification of trees, shrubs and herbaceous plants is very common. Therefore, in quoting hosts from literature one should be very conservative and should consider carefully the source from which the information is derived. The host trees given below are actual hosts, verified by Doctor J. M. Swaine or the author, and the beetles were personally collected from the trees, except for a few well authenticated records.

Coniferous Host Trees and Their Ipid Fauna

host—*Pinus ponderosa* Laws.

1. *Dendroctonus brevicomis* Lec.*
2. *Dendroctonus monticolae* Hopk.*
3. *Ips confusus* Lec.*
4. *Ips oregoni* Eichh.*
5. *Ips emarginatus* Lec.*
6. *Ips latidens* Lec.
7. *Ips integer* Mann.
8. *Dendroctonus valens* Lec.
9. *Gnathotrichus retusus* Lec.
10. *Pityogenes carinulatus* Lec.
11. *Pityogenes fossifrons* Lec.
12. *Conophthorus ponderosae* Hopk.
13. *Orthotomicus ornatus* Swaine.
14. *Hylurgops subcostulatus* Mann.
15. *Hylurgops rugipennis* Mann.
16. *Carphoborus simplex* Lec.
17. *Pityophthorus confinus* Lec.
18. *Pityophthorus confertus* Swaine.
19. *Pityophthorus serratus* Swaine.
20. *Xyloborus xylographus* Say.
21. *Trypodendron ponderosae* Swaine.

host—*Pinus lambertiana* Dougl.

1. *Dendroctonus monticolae* Hopk.*
2. *Ips emarginatus* Lec.*
3. *Ips confusus* Lec.
4. *Ips latidens* Lec.
5. *Dendroctonus valens* Lec.
6. *Conophthorus lambertianae* Hopk.
7. *Carphoborus simplex* Lec.
8. *Gnathotrichus retusus* Lec.
9. *Hylurgops subcostulatus* Mann.
10. *Hylurgops rugipennis* Mann.
11. *Pityophthorus confinus* Lec.
12. *Pityophthorus tuberculatus* Eichh.
13. *Pityophthorus confertus* Swaine.

*Species known to kill living trees.

HOST—*Pinus jeffreyi* "Oreg. Com."

1. *Dendroctonus jeffreyi* Hopk.*
2. *Ips emarginatus* Lec.*
3. *Ips oregoni* Eichh.*
4. *Ips radiatae* Hopk.
5. *Ips latidens* Lec.
6. *Dendroctonus valens* Lec.
7. *Gnathotrichus retusus* Lec.
8. *Pityogenes carinulatus* Lec.
9. *Hylurgops subcostulatus* Mann.
10. *Hylastes macer* Lec.
11. *Orthotomicus ornatus* Swaine.
12. *Pityophthorus confinus* Lec.
13. *Pityophthorus confertus* Swaine.

HOST—*Pinus contorta* Loudon

1. *Dendroctonus monticolae* Hopk.
2. *Ips vancouveri* Swaine.
3. *Ips oregoni* Eichh.
4. *Ips plastographus* Lec.
5. *Ips radiatae* Hopk.
6. *Ips interpunctus* Eichh.
7. *Ips latidens* Lec.
8. *Pityogenes carinulatus* Lec.
9. *Pityogenes knechteli* Swaine.
10. *Pityogenes fossifrons* Lec.
11. *Hylurgops pinifex* Fitch.
12. *Gnathotrichus retusus* Lec.
13. *Orthotomicus ornatus* Swaine.
14. *Dendroctonus valens* Lec.
15. *Dendroctonus murrayanae* Hopk.
16. *Pseudohylesinus sericeus* Mann.
17. *Pityophthorus confertus* Swaine.
18. *Pityophthorus atratulus* Lec.
19. *Hylurgops lecontei* Swaine.
20. *Hylurgops rugipennis* Mann.
21. *Hylurgops subcostulatus* Mann.
22. *Scierus annectans* Lec.

HOST—*Pinus sabiniana* Dougl.

1. *Ips latidens* Lec.*

HOST—*Pinus monticola* Dougl.

1. *Dendroctonus monticolae* Hopk.*
2. *Ips vancouveri* Swaine.
3. *Ips latidens* Lec.
4. *Ips integer* Eichh.
5. *Ips confusus* Lec.
6. *Pityophthorus confertus* Swaine.
7. *Eccoptogaster monticolae* Swaine.
8. *Hylurgops rugipennis* Swaine.
9. *Hylurgops porosus* Lec.
10. *Hylastes nigrinus* Mann.
11. *Dendroctonus valens* Lec.
12. *Pityogenes fossifrons* Lec.
13. *Gnathotrichus sulcatus* Lec.

HOST—*Pinus radiata* Don.

1. *Ips radiatae* Hopk.
2. *Ips plastographus* Lec.
3. *Dendroctonus valens* Lec.
4. *Hylastes nigrinus* Mann.
5. *Hylurgops rugipennis* Mann.
6. *Pseudohylesinus sericeus* Mann.
7. *Carphoborus radiatae* Swaine.
8. *Pityophthorus carmeli* Swaine.
9. *Pityophthorus atratulus* Lec.
10. *Conophthorus radiatae* Hopk

HOST—*Pinus balfouriana* Murr.

1. *Dendroctonus monticolae* Hopk.
2. *Ips vancouveri* Swaine.
3. *Dendroctonus valens* Lec.
4. *Hylurgops rugipennis* Mann.
5. *Hylurgops pinifex* Fitch.

HOST—*Pinus monophylla* Torr. & Fremont.

1. *Ips confusus* Lec.

HOST—*Pinus torreyana* Torr.

1. *Pityophthorus torreyanae* Swaine.

HOST—*Abies concolor* Parry

1. *Pseudohylesinus granulatus* Lec.*
2. *Eccoptogaster ventralis* Lec.*
3. *Eccoptogaster praeceps* Lec.*
4. *Platypus wilsoni* Swaine.
5. *Gnathotrichus sulcatus* Lec.

HOST—*Abies magnifica* Murr.

1. *Pseudohylesinus granulatus* Lec.*
2. *Leperisinus imperialis* Eich.
3. *Eccoptogaster ventralis* Lec.*
4. *Platypus wilsoni* Swaine.
5. *Gnathotrichus sulcatus* Lec.
6. *Pityokteines elegans* Swaine.

HOST—*Abies grandis* Lindl.

1. *Eccoptogaster ventralis* Lec.
2. *Pseudohylesinus granulatus* Lec.
3. *Pseudohylesinus grandis* Swaine.
4. *Conophthorus monticolae* Hopk.
5. *Gnathotrichus sulcatus* Lec.
6. *Cryphalus subconcentralis* Hopk.

HOST—*Abies lasiocarpa* Hook.

1. *Dryocoetes confusus* Swaine.*
2. *Ips borealis* Swaine.
3. *Cryphalus canadensis* Chamb.
4. *Trypodendron ponderosae* Swaine.
5. *Pityokteines jasperi* Swaine.*
6. *Orthotomicus lasiocarpi* Swaine.
7. *Pityophthorus pseudotsugae* Swaine.
8. *Platypus wilsoni* Swaine

HOST—*Pseudotsuga taxifolia* Britt.

1. *Dendroctonus pseudotsugae* Hopk.*
2. *Pseudohylesinus nebulosus* Lec.*
3. *Pseudohylesinus grandis* Swaine.
4. *Eccoptogaster ventralis* Lec.
5. *Eccoptogaster unispinosus* Lec.
6. *Eccoptogaster tsugae* Swaine.
7. *Eccoptogaster monticolae* Swaine.
8. *Platypus wilsoni* Swaine.
9. *Trypodendron cavifrons* Mannh.
10. *Pityokteines minutus* Swaine.
11. *Pityophthorus confinus* Lec.
12. *Pityophthorus pseudotsugae* Swaine*
13. *Gnathotrichus sulcatus* Lec.
14. *Gnathotrichus retusus* Lec.
15. *Hylastes nigrinus* Mann.
16. *Hylastes ruber* Swaine.
17. *Dryocoetes pseudotsugae* Swaine.
18. *Cryphalus subconcentralis* Hopk.
19. *Trypodendron ponderosa* Swaine.

HOST—*Pseudotsuga macrocarpa* Torr.

1. *Dendroctonus pseudotsugae* Hopk.

HOST—*Picea engelmanni* Engelm.

1. *Dendroctonus borealis* Hopk.*
2. *Ips engelmanni* Hopk.
3. *Ips tridens* Mann.
4. *Ips dubius* Swaine.
5. *Ips yohoensis* Swaine.
6. *Dryocoetes septentrionis* Mann.
7. *Dryocoetes affaber* Mann.
8. *Orthotomicus ricinus* Lec.
9. *Scierus annectans* Lec.
10. *Trypodendron ponderosae* Swaine.
11. *Pityophthorus intextus* Swaine.

HOST—*Picea sitchensis* Bong.

1. *Dendroctonus obesus* Mann *
2. *Ips vancouveri* Swaine.
3. *Ips concinnus* Mann.
4. *Ips interruptus* Eichh.
5. *Crypturgus borealis* Swaine.
6. *Dolurgus pumilus* Mann.
7. *Dryocoetes septentrionis* Mann.
8. *Dryocoetes affaber* Mann.
9. *Pseudohylesinus sitchensis* Swaine.
10. *Platypus wilsoni* Swaine.

HOST—*Picea canadensis* Mill.

1. *Ips interruptus* Eichh.
2. *Carphoborus carri* Swaine.
3. *Pityophthorus intextus* Swaine.

HOST—*Libocedrus decurrens* Torr.

1. *Phloeosinus punctatus* Lec.*
2. *Phloeosinus vandykei* Swaine.*
3. *Phloeosinus hoppingi* Swaine.

HOST—*Juniperus scopulorum* Sarg.

1. *Phloeosinus hoppingi* Swaine.

HOST—*Juniperus occidentalis* Hook.

1. *Phloeosinus juniperi* Swaine.*
2. *Phloeosinus rugosus* Swaine.

HOST—*Sequoia sempervirens* Endl.

1. *Phloeosinus sequoiae* Hopk.
2. *Phloeosinus cupressi* Hopk.

HOST—*Sequoia gigantea* Dec.

1. *Phloeosinus punctatus* Lec.

HOST—*Cupressus macrocarpa* Hartw.

1. *Phloeosinus cupressi* Hopk.

HOST—*Cupressus sargentii* Jepson.

1. *Phloeosinus cupressi* Hopk.
2. *Phloeosinus minutus* Swaine.

HOST—*Thuja plicata* Don.

1. *Phloeosinus punctatus* Lec.
2. *Phloeosinus sequoiae* Hopk.

HOST—*Tsuga mertensiana* Bong.

1. *Eccoptogaster tsugae* Swaine.
2. *Gnathotrichus retusus* Lec.

HOST—*Tsuga heterophylla Raf.*

1. *Pseudohylesinus tsugae* Swaine.
2. *Gnathotrichus sulcatus* Lec.
3. *Platypus wilsoni* Swaine.

HOST—*Larix occidentalis* Nutt.

1. *Dendroctonus pseudotsugae* Swaine.
2. *Orthotomicus vicinus* Lec.
3. *Pityophthorus intextus* Swaine.

IPIDAE OF PACIFIC COAST AND ROCKY MOUNTAIN REGION

Carphoborus Eich.
- *carri* Sw. b.
- *radiatae* Sw. a.
- *simplex* Lec. a.

Conophthorus Hopk.
- *lambertianae* Hopk. a.
- *monticolae* Hopk. a, b.
- *ponderosae* Hopk. a.
- *radiatae* Hopk. a.

Cryphalus Fr.
- *canadensis* Chamb. b.
- *subconcentralis* Hopk. b.

Crypturgus Erichs.
- *borealis* Sw. b.

Dendroctonus Erichs.
- *borealis* Hopk. b
- *brevicomis* Lec. a. b.
- *jeffreyi* Hopk. a.
- *monticolae* Hopk. a. b.
- *murrayanae* Hopk. b.
- *obesus* Mann. b.
- *pseudotsugae* Hopk. a. b.
- *valens* Lec. a. b.

a. Records from California.
b. Records from British Columbia.
a.b. Records from California and British Columbia.

Dolurgus Eichh.
pumilus Mannh. b.

Dryocoetes Eichh.
affaber Mannh. b.
confusus Sw. b.
pseudotsugae Sw. a. b.
septentrionus Mannh. b.

Eccoptogaster Herbst.
monticolae Sw. b.
praeceps Lec. a.
tsugae Sw. b.
unispinosus Lec. a. b.
ventralis Lec. a. b.

Gnathotrichus Eich.
retusus Lec. a. b.
sulcatus Lec. a. b.

Hylurgops Lec.
lecontei Sw. b.
pinifex Fitch a.
sorosus Lec. b.
rugipennis Mannh. a. b.
subcostulatus Mannh. a. b.

Hylastes Er.
macer Lec. a. b.
nigrinus Mannh. a. b.
ruber Sw. b.

Ips De Geer.
borealis Sw. b.
concinnus Mannh. b.
confusus Lec. a.
dubius Sw. b.
emarginatus Lec. a. b.
engelmanni Sw. b.
interpunctus Eich. a.
interruptus Eich. b.
integer Eich. a. b.
latidens Lec. a. b.
oregoni Eich. a. b.
plastographus Lec. a.
radiatae Hopk. a. b.
tridens Mannh. b.
vancouveri Sw. a. b.
yohoensis Sw. b.

Leperisinus Reitter.
imperialis Eich. a.

Orthotomicus Ferr.
lasiocarpi Sw. b.
ornatus Sw. a. b.
vicinus Lec. b.

Platypus Herbst.
wilsoni Sw. a. b.

Phloeosinus Chap.
cupressi Hopk. a.
hoppingi Sw. a. b.
juniperi Sw. a.
minutus Sw. a.
punctatus Lec. a. b.
rugosus Sw. a.
sequoiae Hopk. a. b.
vandykei Sw. a.

Pityophthorus Eich.
atratulus Lec. a. b.
carmeli Sw. a.
confinis Lec. a.
confertus Sw. a. b.
intextus Sw. b.
pseudotsugae Sw. a. b.
serratus Sw. a.
torreyanae Sw. a.
tuberculatus Eich. a.

Pityokteines Fuchs.
elegans Sw. a. b.
jasperi Sw. b.
minutus Sw. a.

Pityogenes Bedel.
carinulatus Lec. a. b.
fossifrons Lec. a. b.
knechteli Sw. b.

Pseudohylesinus Sw.
grandis Sw. b.
granulatus Lec. a. b.
nebulosus Lec. a. b.
sericeus Mannh. a. b.
sitchensis Sw. b.
tsugae Sw. b.

Scierus Lec.
annectans Lec. b.

Trypodendron Steph.
ponderosae Sw. b.
cavifrons Mannh. a. b.

Xyleborus Eich.
xylographus Say a.

Such species as *Pinus jeffreyi, radiata, balfouriana, sabiniana, torreyana* and others found in California and not in British Columbia are often hosts of species not found further north and in British Columbia the spruces breed species not found as far south as California, depending largely on the distribution of their hosts. Of the ninety-two species listed thirty-five are common to British Columbia and California and probably to Oregon and Washington; twenty-four are found in California and not as yet in British Columbia, and thirty-three are found in British Columbia and not in California. The distribution of species listed only from British Columbia and California depends largely upon the distribution of the hosts upon which they breed. Some of the species such as *Dendroctonus brevicomis* (*barberi*), *Dendroctonus monticolae* (*ponderosae*) extend south through the Rockies to Colorado, New Mexico and Arizona; this is probably also true of several *Ips* and *Pityophthorus*. Very little is known of the smaller Ipids inhabiting the central Rockies south of Alberta and British Columbia.

In regard to the deciduous trees of this region, *Anisandrus pyri* Peck has been found in apple at Vancouver and in Oregon and *Leperisinus californicus* Sw. in olive in California. The latter species is a native of the chapparal, apparently breeding in some of the numerous species of *Ceanothus*.

Alniphagus aspericollis Lec. breeds in *Alnus oregona* Nutt. and *Trypodendron retusus* Lec. in *Populus tremuloides* Mich. both in British Columbia and California, and they are probably found wherever the western alders and poplars exist. *Betula occidentalis* Hook. is the host of *Dryocoetes betulae* Hopk. in British Columbia. Several other species have been reported from the western coast but have not been verified by the author.

Dr. Hopkins* reports *Xyleborus arbuti* Hopk. from *Arbutus menziesii* Parsh. from Calif., *Cryphalus pubescens* Hopk. from *Abies grandis* Lindl. Port Williams, Wash., and *Cryphalus approximatus* Hopk. from *Abies grandis* Lindl. Several other Ipid species not in the list are known from this region but the hosts have not yet been determined.

NOTES ON THE LEPIDOPTERA OF ALBERTA

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The months of June, July and part of August, 1921, were spent by me in Nordegg, Alta., collecting insects for the Canadian National Collection. This locality has of late years become more or less famous through the entomological activities of Messrs. K. Bowman of Edmonton and F. C. Whitehouse of Red Deer, this latter gentleman having published an interesting account of the region and its dragonfly fauna in the Canadian Entomologist, 1918, L. pp. 1, 95.

In spite of rather adverse weather conditions and a remarkable lack of warm, clear days a very interesting collection of Lepidoptera was obtained; most of the species have already been recorded in Mr. Bowman's Check List of Alberta Lepidoptera but several new records were secured; these are embodied

*Class. of the Cryphalinae.

in the present paper, together with notes on a few other obscure species which may help to clear up their specific status.

Eurymus gigantea Stkr.—The species has always been considerable of a puzzle to entomologists. Strecker described it as a form of *pelidne* and Staudinger under the name *pelidneides* placed it as a form of *palaeno;* the material on which both these names was based came from the West Coast of Hudson Bay, north of Ft. Churchill. After an examination of Strecker's types it was referred by me (1917, B. & McD., Contributions, III, (2), 68) to *christina* as a yellow variety. Wolley-Dod in his notes on Albertan Lepidoptera (Can. Ent. XXXIII, 19; l. c. XL, 187) places it doubtfully under the name *occidentalis*, mentioning that he could only separate it from *christina* by color but hazarding the opinion that two species were involved. I first met with this yellow species at Nordegg about the middle of July and soon found that it was practically entirely restricted to the muskegs. *Christina* was commonly found on the dry slopes and could be taken throughout July around the flowers growing in such locations; to obtain *gigantea*, however, it was necessary to visit the muskegs. It was further noticed that the females of *gigantea* were yellow whereas those of *christina* belonged to the whitish form. This gave rise to strong suspicions in my mind that I was dealing with species rather than with forms and I resolved if possible to secure data regarding the food-plants. It was comparatively easy to discover that the females of *gigantea* were depositing ova on the leaves of the several varieties of dwarf willows so prevalent on the hillocks of the muskeg. Several freshly deposited eggs were secured. These, I might mention, hatched in about ten days, the young larvae resting on the mid-rib of the leaf and eating small portions of the upper epidermis; they showed little signs of growth and on leaving Nordegg I was forced to relinquish them; the larvae evidently hibernates in a very early stage.

With *christina* I had more difficulty but was finally successful in surprising one of the large white females depositing an egg (which I secured) on a small species of lupine with greenish-white flower. The above differences in larval food-plant and habits constitute a valid reason to my mind for considering *gigantea* and *christina* to be distinct species. Willow as a food-plant is most unusual in the *Eurymus* group and the only other record of a similar food-plant which I have been able to find is given by Edwards (Butt. N. Am. III, Suppl. Notes) who mentions that Bruce saw females of *scudderi* in Colorado depositing ova on willow and that he himself reared larvae of this species to the third moult on weeping-willow. As *scudderi* is an inhabitant of the high peat moors of the Coloradan Rockies, a close relationship between *gigantea* and *scudderi* is not improbable. As regards the points of distinction between *gigantea* and *christina* I must agree with Wolley-Dod that the color is practically the only means of separation; I have seen no *gigantea* males with even the faintest suspicion of orange color whilst on the other hand *christina*, even in advanced *astraea* forms, shows slight orange shades beyond the cell and along the veins. Generally speaking the discal mark on under side of secondaries is single in *christina* and more or less double in *gigantea* but this character is not entirely constant. The color of the females is probably also not constant, although in the Nordegg region and similar regions of Alberta it is a valuable aid to identification.

Oeneis taygete Bdv.—To my surprise I captured on the Coliseum Mt. (6500 ft.) a series of this species flying over the dry grassy slopes along with *brucei* Edw. Apart from the genitalia it is best distinguished from *brucei* by the white veins on the underside of secondaries and the presence of a black median line on underside of primaries. *Taygete* has not previously been recorded from Alberta although its occurrence in the Yukon Territory and extreme northern British Columbia has long been known.

Heodes florus Edw.—This species apparently bears the same relationship to *helloides* Reak. that *Eurymus gigantea* does to *christina* Edw., i. e., it is a typical inhabitant of the bogs and muskegs whereas *helloides* flies on dry hillsides and on the open prairie.

At Nordegg the species was decidedly rare although widespread, and during the last of July and the early part of August isolated individuals could usually be taken by a careful search of the few flowering plants present at this time in the muskeg.

The name *florus* was proposed by W. H. Edwards (Can. Ent. XV, 210) for a species collected by Capt. Gamble Geddes in 1883 while on a trip from Edmonton south to the Crow's Nest Pass, in which the present line of the C. P. R. railroad from Edmonton to MacLeod was roughly followed; in the original description the locality is given as "Red Deer River" but Capt. Geddes later (Can. Ent. XV, 223) changes this to "Garnett's Ranch." The Geddes collection, now incorporated in the Canadian National Collection, contains six males of this species, four labelled "Calgary, July 4, '83" and the other two "Crow's Nest Pass, Aug. 10, '83." It is probable therefore that the type specimens were taken at various points along the above-mentioned route, as Geddes was neither very precise nor accurate in his data regarding localities. In any case, as the Nordegg specimens agree exactly with Geddes' material, it seems safe to assume that *florus* inhabits the bogs and swamp regions of the Rocky Mt. foothills.

In our latest Check List *florus* has been listed as a variety of *helloides* but in view of its habitus I believe that it should rather be associated with *dorcas* Kby. which inhabits similar regions and the larva of which feeds on cinquefoil (*Dasiphora fruticosa*) and potentilla (Newcomb, Can. Ent. XLI, 221). In fact it would be a matter of small surprise to me if my Nordegg specimens should prove to be more nearly typical of *dorcas* than the Michigan specimens recorded by Newcomb under this name.

Dorcas was described by Kirby (1837, Fauna Bor. Am. IV, 299) from a female specimen collected in "Lat. 54", which I might note is only slightly north of Edmonton, and the type specimen is probably lost. The figure given (Pl. IV, fig. 1) shows distinct orange shading in the postmedian area of primaries and the anal angle of secondaries contains *two* orange lunules. One of my Nordegg ♀'s matches this figure quite closely, although the average ♀ from this region appears to possess more orange on primaries and *three* orange lunules on secondaries. On the other hand in a Michigan series before me from Dr. Newcomb the females in general show decidedly less orange than in Kirby's figure, the anal lunules being either reduced to a single one or lacking entirely. Judging from the series before me, however, the amount of orange shading on

primaries and the number of orange lunules on secondaries in both sexes is variable and of little value as a specific character. In other respects I can see no tangible differences between the Nordegg and the Michigan series.

Helloides does not apparently fly at Nordegg but Mr. K. Bowman records it in his Alberta List from Edmonton, Red Deer, etc., and there is a single ♂ in the Dod Collection from the Calgary region. The Canadian National Collection contains a very typical series from various Manitoba prairie localities, the female being of the large coppery form and the marginal lunules in both sexes well developed. *Dorcas* is also present in certain Manitoba bogs; it was recorded by E. F. Heath (Can. Ent. XXXI, 95) as a variety of *helloides* and Mr. N. Criddle takes it each year in a bog near Aweme, Man., where potentilla grows. These Aweme specimens cannot be separated from the Nordegg ones.

While there is no doubt that we have two forms in the Canadian Prairie Provinces, primarily distinguished by their markedly distinct habitus and on this account doubtless entitled to specific rank, it seems hardly probable that a third good species exists in this region. In view therefore of the essentially similar nature of the faunal regions in which the type specimens of *dorcas* and *florus* were captured, the most logical proceeding would seem to be to sink *florus* as a synonym of *dorcas*.

Apantesis turbans Christ.—The larvae of this species were quite common in June on dry slopes and meadows. They were very constant in maculation and the following brief description is offered.

Head shiny black, with posterior portion of cheeks orange. Body jet black with short black spiculate hairs from tubercles in dorsal and subdorsal area and red hairs laterally and as a fringe over the head. Pale broken dorsal line consisting of two spots on each segment, a small circular one on the posterior edge of the segment and a linear dash on the anterior edge, closely approximate to the circular one, which has much the size, shape and color of a Tachinid egg. A few longer black hairs at posterior end of body.

The dotted dorsal line is quite characteristic and separates the larva at once from that of *virguncula*. I have grave doubts as to whether the species can be considered to be a form of *quenseli* Payk.; a comparison of the larvae of the two forms should decide this point; whether or not the name *turbans* is correctly applied is also a point for systematists having access to Siberian material to settle.

Mr. A. Gibson has given good figures of the species in the Canadian Entomologist, 1903, Vol. XXXV, Plate V; he also figures a specimen which had been identified by Dr. Dyar as *obliterata* Stretch; this specimen is very obviously a form of *turbans* but I am not certain that it actually represents *obliterata* as figured by Stretch in Journal New York Entom. Society, 1906, Plate VI, fig. 14. In this latter figure the veins of the fore wings, notably vein 2, are much more continuously outlined in white than in any Albertan specimens of *turbans* in the long series I have before me, approaching in this respect *virguncula*. A few of the specimens captured or bred at Nordegg show reddish tinges on secondaries and one specimen in the National Collection from Aweme, Man., is very decidedly red.

Euxoa westermanni Staud.—Mr. K. Bowman and myself took six or

seven specimens at light about the middle of July which seem to belong to this species. They agree excellently with Smith's characterization in his Agrotid revision and match fairly closely Aurivillius' figure in Greenland's Insect-fauna. Hampson's figure under this name (Cat. Lep. Phal. IV, Pl. 69, fig. 20) is evidently based on a misidentification and should be referred to *Epipsilia wockei* Moesch.

Apharetra dentata Grt.—A single ♂ taken by Mr. Bowman and a ♀ captured by myself at light during the third week of July I am inclined to refer to the above name. These two specimens differ from *pyralis* Sm. (of which part of the type series from Calgary and a very fine ♂ from High River, Alta., are before me) in the much paler color of the primaries, which are distinctly light-gray shaded with black rather than black suffused with gray (*pyralis*). In a notebook of Mr. Wolley-Dod's, containing unpublished comments on the British Museum types, I find under *dentata* the following, "Looks exactly like a pale *pyralis*. Figure (Hampson. Cat. Lep. Phal. Brit. Mus. IV, Pl. LXXVIII, fig. 21) much too contrasting." This remark characterizes the Nordegg specimens excellently and leads me to the above reference; I am not convinced that *dentata* and *pyralis* represent two specific units but for the present they may stand separated.

Acronycta canadensis Sm.—The name *canadensis* was tentatively applied in Smith and Dyar's monograph of the genus (p. 57) to two specimens from Murray Bay, Que., and Calgary, Alta. In his notes on Alberta Lepidoptera, Mr. F. H. Wolley-Dod (Can. Ent. 1904, p. 353; op. cit. 1911, p. 148) offers some remarks on this species, stating that the Calgary ♀ is marked type in the U. S. National Museum and that he has a ♀ in his collection from the same locality marked by Smith as agreeing with type; this ♀ is now in the Canadian National Collection. At Nordegg I captured three specimens at light which agree well with the above mentioned ♀; I also was successful in securing several larvae sitting in their characteristic manner on the upper side of aspen leaves and from these bred two ♂s and one ♀. These larvae were covered with long yellowish hairs with five dorsal black hair-pencils from tubercle I on joints 5, 7, 8, 9 and 12; they appeared to me to be in no wise different from larvae of *populi* Riley with which I was familiar from numerous specimens found on poplar in Decatur, Ill. I also obtained similar larvae and a resulting series of bred specimens at Norway Point, Lake of Bays, Ont., in 1920. Compared with my Alberta specimens eastern specimens (Chicago, Ill.; New Brighton, Pa.; Ottawa, Ont.; Lake of Bays, Ont.) are decidedly more suffused with white scaling in the central areas of primaries, the Nordegg specimens being rather evenly blue-gray in coloration of primaries, approaching in this respect the *felina* group. A tendency in this direction is, however, distinctly noticeable in certain of my bred Lake of Bays material, notably the ♀'s, and a pair before me from Larder Lake, Ont. (Nipigon region), is quite as suffused as the Albertan series. I can see no essential difference in the maculation of the various series; the length of the black basal dash, so much emphasized by both Smith and Hampson, is obviously of no specific value and depends on the amount of white hairs or scales in that particular region in the individual specimens. I have long been of the opinion that in this particular group we have more names than species on our lists and this view was shared by Mr. Wolley-Dod (Can. Ent. 1918, p. 49) in his criticism

of the 1917 Check List. I have recently received a photograph of the type ♀ of *lepusculina* Gn. through the kindness of Mr. F. LeCerf of the Paris museum, and in the light of the above remarks believe that both *populi* Riley and *chionochroa* Hamp. will fall to *lepusculina* Gn.; *canadensis* Sm. may be retained for the darker western race and *cinderella* Sm. with *transversata* Sm. as a probable synonym will apply to the Colorado form, concerning which at the present time I have not sufficient fresh material before me to form an opinion. I might note that in Manitoba (Winnipeg, Aweme) we meet with an extremely white form which is liable to be confused with *cretata* Sm.; this may be worthy of a name but for the present I include it under *cinderella* Sm.

Autographa diasema Bdv.—In a recent paper on Labrador Lepidoptera (Can. Ent. 1921, p. 85) I associated *diversigna* Ottol. with this species as a western race of same. I believe now, in the light of specimens collected at Nordegg, that this was a mistake and that we are dealing with good species. I took a number of fresh specimens of *diversigna* at light during July and further a single specimen in beautiful condition on July 13th, which at the time looked different, due to the duller color of the secondaries. On returning to Ottawa I found that this Nordegg specimen agreed excellently with the Labrador specimen mentioned above and also with a specimen of *diasema* I had discovered in the Wolley-Dod collection labelled "Lule, Lappmark;" Mr. Bowman, at my request, looked through his series of *diversigna* and sent me for examination two specimens from Nordegg which also proved to be *diasema*. Apart from the duller-colored secondaries *diasema* is most readily separated from *diversigna* by the fact that the metathoracic tufting lacks the bright-brown tinges characteristic of *diversigna;* the gray areas of the primaries are also more decidedly gray and show less of the purplish suffusion of *diversigna* and the area enclosed by the U mark has no reddish filling as is often the case in the latter species. These differences are slight but in view of the fact that both forms occur in the same territory and can be separated without much difficulty on the above characters, I thing that Dr. Ottolengui's contention that two species are involved should be accepted.

Cerura occidentalis gigans var. nov.

Several specimens of a puzzling *Cerura* species were captured at light; from a female a number of eggs were obtained and the resulting larvae brought successfully through to pupation; a few of the pupae emerged unexpectedly the same fall and the adults were found later in a totally battered condition; one pupa emerged early in 1922, but the remainder appear to be holding over for a second year. A brief description of the various larval stages was made and from a comparison with existing descriptions, the larva appears to approach very closely to that of *occidentalis* Lint. On comparing the Nordegg adults with the material in the National Collection it was found that they were similar to a long series taken by Mr. Wolley-Dod in the Calgary region and referred to by him in his notes on Alberta Lepidoptera (Can. Ent. 1913, p. 299) under the name *Harpyia scolopendrina* Bdv. They can however be at once distinguished from this species by the smokier nature of the white ground color and by the fact that the row of black dots on the basal side of the median dark band is distinctly made up of five dots and not of four. From typical *occidentalis* they differ in their much larger size and the noticeably darker character of the median and subapical black bands; as

however they agree with *occidentalis* in other particulars of maculation and apparently also in the early stages it would appear best to regard our Alberta specimens as a western race of *occidentalis* for which I propose the above varietal name. The Holotype male in the Canadian National Collection is labelled "Head of Pine Creek, Calgary, Alta. (May 29, 1910) (F. H. Wolley-Dod)," the Allotype ♀ is from the same locality (29th April, 1915) and there is also a series of Paratypes from this locality before me; a single specimen from Kaslo, B. C., is in our National Collection, labelled *scolopendrina*. I append the larval notes drawn up from the Nordegg specimens.

Egg. Black; similar in shape to other members of the genus.

Larva, Stage I. Head red; body black, tinged with reddish laterally and turning later to deep red-brown. Prothorax with usual side protuberances. Dorsally an oval yellow patch extending over metathorax and abdominal segment I; a similar but narrower yellow patch dorsally over abdominal segments IV-VI. Filaments blackish-red crossed by two pale bands.

Stage II. Head and body deep red-black. The yellow patches much as in preceding stage; the one on metathorax and 1st abdominal almost square with the anterior corners generally jutting forward partly across the mesothorax and not continued so far back across abdominal segment I. Prolegs and ventral surface dull greenish gray. Tubercles small, black, with short black hairs. Anal plate black. Filaments banded twice with yellow and with pale reddish tips.

Stage III. The yellow thoracic patch has become divided into two lateral triangles of yellow due to the meeting centro-dorsally of the apices of dark triangles. Laterad of these yellow triangles the body-color is greenish, tinged with brown, this color extending on to the 2nd abdominal segment on a line continuing the lateral edge of the yellow triangle. The abdominal yellow triangle has either completely disappeared or is reduced to a diffuse yellowish shading cut by a geminate dark centro-dorsal line. On abdominal segments III-VIII the dark ground color extends below spiracle, on VI-VIII being slightly shaded with paler marking. Legs, prolegs and venter greenish, on VII-last segments with brown central shading. Filaments brown, cut twice by yellow.

Later in the stage the green lateral thoracic coloring merges with the yellow leaving the characteristic dorsal brown triangle bordered with yellow with posterior apex at rear of mesothorax, and a further triangular dorsal dark patch with apex touching that of the thoracic triangle and with its lateral edges extending backward and downward to below spiracle on abdominal segment III, thence running below spiracles of segments IV and V and bent upward to a point on anterior margin of VIII just behind tubercle II, then slightly downward again to rear segment.

Stage IV. Larva of the typical *Cerura* form. Head purple-brown shaded with paler laterally and frontally. Body with the dorsal portion purple-brown, roughly divided into 3 areas; a triangular thoracic section, a saddle-shaped abdominal region and a small diamond shaped anal portion, all connected and bordered laterally by a yellow line. The triangular thoracic portion has its apex at the dorsal rear of the mesothorax at which point there are two slight protuberances; the lateral edges of the saddle meet almost at a point immediately behind these tubercles, then slope rapidly and obliquely to a point on rear of 2nd abdom-

inal segment in a line with the spiracle; on the 3rd abdominal segment a rectangular downward projection is formed including the spiracle and on the 4th a similar rectangular projection extends the dark color to the base of the prolegs with generally the lowest point between the first two pairs of prolegs. From here the edges slope rapidly upward to the subdorsal area of the 8th segment, being at this point about 1-1½ mm. apart, then broaden considerably across the 9th, narrowing again on 10th, thus forming the above mentioned anal diamond patch. At the deepest point of the saddle there is considerably diffuse ochreous shading forming a lateral patch on 3rd and 6th abdominal segments and in late stages there is a marked tendency for the whole saddle area to become paler. From the rear of the metathoracic legs a purple band, bordered on upper side by yellow, extends ventrally backward across 1st and 2nd abdominal segments and there is an oblique band of same color on prolegs which on 7th-10th abdominal segments forms a broad band of dark color, often coalescing with a centroventral dark line found on these same legs. Lateral area of body green with sparse yellow sprinkling and orange spiracles.

THE DAILY MAXIMUM FEEDING PERIOD OF MELANOPLUS FEMUR-RUBRUM. *

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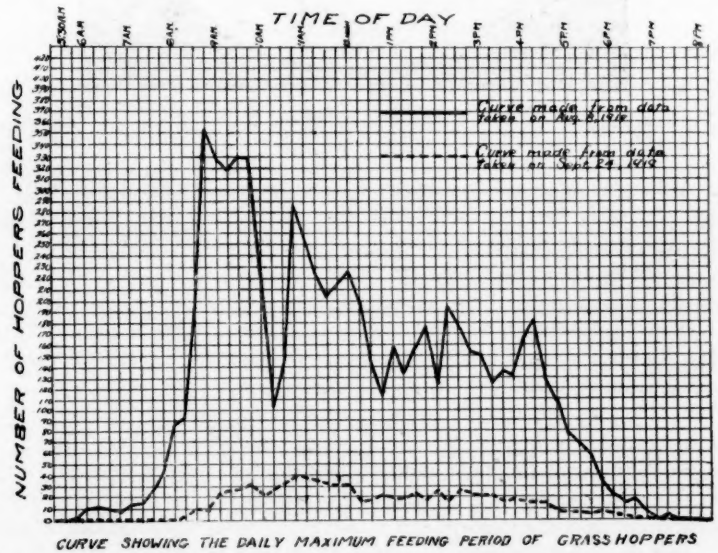
While making a study of the feeding habits of *Melanoplus femur-rubrum* at Lafayette, Indiana, during the late summer of 1919, it was possible to obtain some data on the time of day the maximum feeding period of this species occurred.



CURVE SHOWING THE DAILY MAXIMUM FEEDING PERIOD OF GRASSHOPPERS

* Published by permission of the Secretary of Agriculture.

The observations by which these data were obtained were made in the following manner: Card-board discs one foot in diameter were placed in an infested field and equal amounts of similarly mixed bran mash put in the center of each. By the use of a pair of field glasses counts were made of all grasshoppers either feeding or within the six inch radius of the baits (Fig. 1) at 15 minute intervals from daylight until dark. Fresh mash was supplied when needed to avoid possible error due to drying. Experiments were run on Aug. 8, 1919, with six cards and again on Sept. 25 with 12 cards. The accompanying curve shows the number of hoppers feeding at each 15 minute interval during these two days. (The time used in these curves is that prescribed by the Daylight Saving Law of 1918 and 1919.)

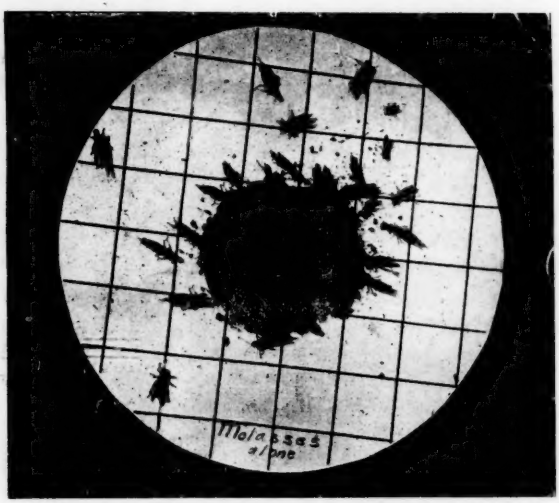


Fig. 1.—Cardboard disk in position in the field showing bran bait and grasshoppers attracted to it.

Although the grasshoppers were much more abundant on Aug. 8 than on Sept. 24, there was but little difference in their maximum feeding periods. The curve for Aug. 8 shows a marked fall at 10.15 A. M. and again at 12.45 P. M., undoubtedly due to the changing of baits at 10.00 A. M. and 12.30 P. M. On Aug. 8 the greater part of the feeding occurred between 8.30 A. M. and 12.30 P. M., while on Sept. 24, 9 A. M. and 12.15 P. M. marked the limits of this period. On Aug. 8 there was considerable feeding activity in the afternoon until 4.15 when it dropped suddenly until 7.15, at which time the last hopper was observed to have fed. On Sept. 24 feeding activities gradually decreased after 2.30 P. M., the last being recorded at 6.30 P. M. These observations indicate that the maximum feeding period for grasshoppers under these conditions occurs between 8.30 A. M. and 12.30 P. M. (new time). Therefore, to obtain the best results from the use of poison bran mash it should be applied in the morning not later than 8.30 A. M. thus having the mash in the field in a moist condition during the maximum feeding period.

While performing these experiments a careful study was made on the habits of grasshoppers with reference to the time of day. It was found that early in the morning the hoppers were inactive and roosting on the tops of grasses and weeds; they would not jump when disturbed, it being possible to pick them off with the fingers. At about 7.30 A. M. some activity was noticed, the hoppers jumping or flying in all directions when disturbed. This activity increased until 10.00 A. M. when it was perhaps at its maximum. They remained in this active condition until about 4 P. M. when they again began to show signs of sluggishness. Between 5.30 and 6.00 P. M. many were found going to roost and by 6.30 P. M. practically all were settled for the night.

SOME CANADIAN BEES

BY T. D. A. COCKERELL,

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In the Canadian Entomologist 1916, pp. 270, 271, 312, Mr. F. W. L. Sladen published three supposed new species of Canadian bees, two of them types of new genera. No detailed descriptions were given and the determination of these forms has remained somewhat problematical. I am indebted to Dr. J. H. McDunnough for the loan of the specimens, in order that some further particulars may be given.

Stelis (*Stelidium*) *trypetina* (Robertson).

S. ontariana Sladen was queried by its describer as *trypetinum*, and I am unable to separate it from Robertson's species. There is only one difficulty, concerning the apical ventral segment of the female. Robertson, in his original description, says there is a subapical carina. In *ontariana* this is not easily observed, but with a side light it can be seen that there is a slight longitudinal ridge or elevation. But Robertson, in a later paper (Trans. Am. Ent. Soc., XXIX, 170) says there is a *transverse* preapical carina. This I cannot see at all, and suspect a slip of the pen.[1] Everything else agrees perfectly.

Many years ago, I described a bee from Sante Fe, New Mexico, as *Stelis lateralis* var. *permaculata*. In 1901 I separated it as a distinct species, finding that it had nothing to do with *lateralis*. It is, in fact, a *Stelidium*, very close to *trypetinum* (*ontariana*). The type (male), compared with the male type of *ontariana*, is found to be smaller (length 4.5 mm.), with the basal nervure slightly basad of the nervulus, more so on one side than the other (exactly meeting it in *ontariana*), wings much clearer (strongly suffused with brown in *ontariana*), white lateral face-marks well developed, especially the lower part (nearly obsolete in *ontariana*). It seems quite possible that these differences are only subspecific, in which case *trypetinum* or *trypetina* will rank as a subspecies of the earlier published *permaculata*.

Chelostoma (*Autochelostoma*) *canadense* (Sladen)

♂, Length about 8 mm.; black, the flagellum (except basally) obscurely

[1]The broad shining apical margin is rather abruptly separated from the dull basal part of the segment and it is possible that this effect might suggest a carina, which is certainly not present.

brownish beneath, tarsi reddened apically; tegulae dark brown; wings dilute fuliginous, with dark stigma and nervures; hair of head and thorax long and white. Process on second ventral segment of abdomen very large, broad, triangular; sixth dorsal segment broadly truncate, with no median tooth, but with small dentiform lateral angles; seventh segment long and acutely pointed. The sixth has faint indications of a subapical fovea, which is bare and shining. The whole insect is glistening, the head and thorax with very fine close punctures. This is a *Chelostoma*, apparently nearest to *C. fovcolatum* (Morawitz) of Europe. In the American fauna it comes closest to *C. californicum* (Cresson), but is easily separated by the characters of the abdomen. Superficially, it has much the appearance of *C. nigricorne* (Nyl)[2] and *C. florisomne* (L).

The venation resembles that of *nigricorne*, except that the marginal cell is considerably shorter, and the second submarginal is less narrowed above.

The recurrent nervures join the second submarginal cell equally distant from base and apex, and the second recurrent is much nearer the end of the cell than in *florisomne*. The head and thorax are more finely and closely punctured than in *florisomne* or *nigricorne*.

Chelostoma (*Formicapis*) *neomexicanum* Ckll.

This was described in Canadian Entomologist, 1904, p. 13. Sladen's *Formicapis clypeata* is the same species. The first recurrent nervure meets the first intercubitus, or goes slightly before or behind it. The clypeus has a median longitudinal groove. The basal nervure exactly meets the nervulus in a Colorado (Florissant) specimen, and in Sladen's Alberta specimen, but in the Manitoba example the basal nervure falls a very little short of the nervulus. The head in the Alberta specimen is larger than in the others. *Autochelostoma* and *Formicapis* may stand as subgenera.

Supplementary Note on Formicapis.

In Peaceful Valley, Colorado, June 18, at flowers of strawberry, Miss Dorothy Young took the hitherto unknown male of *Chelostoma neomexicanum* Ckll. It is about 6.5 mm. long, with dense subapressed dull white hair on face, and pale reddish hair on front vertex and dorsum of thorax. The flagellum is slender, simple, faintly reddish beneath. The venter of the abdomen is simple, the third segment with a median line of hair, the fourth with the margin slightly and very broadly excavated in middle. The apex presents a pair of rounded, very obtuse lobes, close together, and a low dentiform structure on each side. The first recurrent nervure meets the intercubitus or is even a little basad of it. Sladen describes the maxillary palpi as 3-jointed; I have not made a microscopic mount, but I can see three cylindrical joints, and think there is a fourth immovable one.

The male emphasizes the distinction from *Chelostoma*, and I now think we must accept *Formicapis* as a genus, the species becoming *Formicapis neomexicana* (Ckll). The venation and smaller stigma readily distinguish it from Robertson's *Prochelostoma*.—T. D. A. Cockerell, Aug. 14.

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[2]C. *nigricorne* cannot be called by Panzer's name *fuliginosa*, as that was published under *Apis*, and was preoccupied.

Mailed Saturday, September 9th. 1922.